Sweet Vernal-grass *Anthoxanthum odoratum* L. A brief review of a pest problem

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Abstract
It is believed that Sweet Vernal *Anthoxanthum odoratum* L. was introduced into Australia some time before 1887 as a pasture grass. Since then it increasingly has become a threat to native plant communities throughout Australia. This contribution explains why it is a pest and provides a brief discussion on its history and status in Australia. (*The Victorian Naturalist* **127** (4) 2010, 151-154)

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Introduction

This report provides a brief review of the environmental, social, and economic costs caused by the introduced Sweet Vernal-grass *Anthoxanthum odoratum* L. in Australia. The report investigates the ecology of the plant, why it is a pest, its history and status as an Australian weed, its current distribution and its future potential as a problem plant.

Sweet Vernal-grass or 'Sweet Vernal' is a small tufted perennial grass native to Eurasia and North Africa (Platenkamp 1990). It is now present on every continent including Antarctica, and is considered a pest species in many of its introduced regions such as Australia, New Zealand and the Pacific, parts of Europe and America (Pimental *et al.* 2007).

Ecology

Sweet Vernal is a tufted perennial grass and a member of the Poaceae. It has a noticeable scent, which has been described as similar to sweet vanilla or fresh hay (Muyt 2001); it is sometimes called Scented Vernal Grass. Sweet Vernal is an invasive weed and has a number of ecological traits that allow it to successfully naturalise areas into which it has been introduced. It is a highly competitive, hardy species that can occupy a variety of soil types and a range of climatic conditions (Wu and Jain 1980). Indeed, Sweet Vernal is considered the most competitive member of its genus (Platenkamp 1990). Flegrova and Krahulec (1999) suggest Sweet Vernal's altitude range is very broad compared to other members of its genus; for example, although it grows successfully in lower and mid-range altitudes, it also can occupy higher altitudes that are more suited to *Anthoxanthum alpinum* Á. Löve & D. Löve, which is a high-altitude specialist. Sweet Vernal is well known for its genetic adaptability and it can adjust quickly to suit local conditions (Platenkamp 1990). In less than 20 years, the grass can differentiate genetically, allowing it to cover large areas of very different soil and moisture regimes (Platenkamp 1990). Sweet Vernal is perennial; however, it typically has a rapid population turnover of one to two years, although a small proportion of a population can live up to five years (Antonovics 1972). It has been known to behave as an annual species under certain environmental conditions (Antonovics 1972).

Sweet Vernal reproduces by seed and rhizomes (Muyt 2001) but most dispersal is via seed (Muyt 2001). Seeds typically germinate after autumn rain (Antonovics 1972). Seeds are produced in very high numbers (60-1250 seeds per plant annually) (GOERT 2007) with viability often exceeding 80% (Muyt 2001). The majority of seeds germinate within one to two years, but some may remain dormant for several years (Muyt 2001). Following germination, the plant grows rapidly and flowers in its first year of growth, during spring (Antonovic 1972). It can adapt and vary flowering times to suit local conditions (Antonovic 1972) but is much less active in hot summer months (Antonovic 1972).

Sweet Vernal competes aggressively for soil nutrients and moisture. It is shallow-rooted, and produces a dense mat of roots in the top 10 cm of soil. Importantly, it contains allelopathic chemicals that can suppress the growth of competing plants (Berendse 1983; Yamomoto 1995). It con-

tains coumarin which has been demonstrated to inhibit the growth of *Zoysia japonica* on Zoysia-grassland in Japan (Yamomoto 1995).

Why is Sweet Vernal a pest?

Sweet Vernal typically invades disturbed areas such as roadsides, grasslands, woodlands, pastures, and crops (Platenkamp 1990). Due to its ecology and life-history characteristics, Sweet Vernal successfully invades and out-competes Australian native grassland and woodland understorey communities as well as economically important agricultural crops. It is aggressive and can tolerate a variety of environmental conditions, including dry areas and the low-nutrient soils that are characteristic of Australia.

When invading an area, Sweet Vernal forms a dense layer that blocks out light, preventing the growth of other grass species and the regeneration of native plants. Its leaf-litter increases soil nitrogen levels; this is pertinent to its impact on Australian native plant communities as increased nutrients favour non-native plant growth (GOERT 2007), which then would further suppress growth of natives that have evolved to suit low-nutrient soils (GOERT 2007).

Impacts of invasion

Native plant communities throughout Australia are becoming increasingly threatened. Further loss of native habitat through invasion of weeds such as Sweet Vernal, results in lost biodiversity and irreplaceable environmental and economic resources. As well as providing valuable ecosystem processes such as climate regulation, clean air and water regulation, biodiversity provides essential social support to human communities. Native habitats that are visibly degraded can affect a community's sense of wellbeing (Adair and Groves 1998).

In addition to preventing native plant regeneration, Sweet Vernal alters natural ecosystems that provide resources for Australian wildlife, including many rare and threatened species. Sweet Vernal can alter fire regimes and microclimates (Adair and Groves 1998), both of which have many detrimental flow-on effects.

Decreased agricultural crop yields resulting from weed invasions, and the costs associated with weed control, result in economic impacts such as increased production costs and decreased revenues. Flow-on consequences include an increase of pesticides in our environment. While there are no published cost estimates specifically relating to Sweet Vernal, the Victorian government has calculated that the cost of weed invasions in Australian agriculture exceeds $4 billion per annum (DPI 2009).

In Australia, Sweet Vernal invades unimproved pastures; cattle find it unpalatable and show grazing preference for annual grasses, further increasing the rate and extent of invasion. Sweet Vernal is well-known as an allergenic species (Reed 2003), thus its presence can exacerbate hay fever symptoms in spring when it flowers.

Known control methods for this species are labour intensive and costly. Mowing, hand-pulling and chemical control can be effective but must occur before seed-heads set. Continual monitoring is required due to the ability of seed to remain dormant in soil and the ease with which seeds can be spread. Grazing and biological techniques have proven ineffective, and the only effective chemical agents are non-specific, thus can impact non-target species. There are gaps in the knowledge dealing with control methods for Sweet Vernal, and more research is required, particularly focusing on burning techniques and mechanical/biological control (Nature Serve 2009).

History and status

The history of Sweet Vernal as an Australian weed is short compared to its history within America and Europe. It was introduced into America in the 1700s as a pasture grass and became naturalised (Grant and Antonovics 1978). Evidence indicated that it also colonised wastelands in England in the 1800s (Antonovics 1972).

It is believed that Sweet Vernal was introduced into Australia some time before 1887 as a pasture grass (Reed 2003). Initial movements were through hay transport and sale of commercial seed mixtures (Flegrova and Krahulec 1999), enabling it to quickly become widespread. Australian federal government research (RIRDC 2008) indicates that Sweet Vernal did not capture much research attention until the 1970s, and that it has become known as a prominent weed species in Australia only in the last decade. Sweet Vernal is internationally recognised as an invasive weed, having been recorded as such in Columbia, Japan, Chile, Italy, New Zealand, and the USA. In Australia, it is not presently listed as a noxious pest under any state or federal legislation; however, it is informally recognised as a significant invasive species by national and state management authorities.

In 1998, Sweet Vernal was identified as a potential environmental weed and a candidate species for preventive control (Csurhes and Edwards 1998). This was based on the existence of extensive naturalised populations, its potential to spread, and its international history (Csurhes and Edwards 1998). On the Victorian Department of Primary Industries website, it is included in the list of 'Statewide environmental weeds' but is excluded from the list of 'Victorian agricultural weeds' (DPI 2009).

Current distribution

Sweet Vernal is an invasive weed in a range of habitats in southern Australia, but particularly in southern Victoria (Fig. 1). It has invaded a large range of native vegetation communities including dry coastal vegetation, heathland, heathy woodland, grassland, grassy woodland, wetlands, dry and damp sclerophyl forests, alpine vegetation and rainforest (DPI 2009). Within Victoria, a number of these communities are listed as threatened under the *Flora and Fauna Guarantee* Act 1988. These include grasslands in the Victorian Volcanic Plains and Central Gippsland, and Grassy Red Gum Woodland in central Victoria. Sweet Vernal also has invaded large tracts of land in the Dandenong Ranges, the Otways, and in metropolitan Melbourne (Groves *et al.* 2005).

The future

The rate of spread of Sweet Vernal (and other grassy weeds) in Australia has increased dramatically in the last decade. This is due to modern transport technology and continued disturbance to soils and landscapes. In addition to natural distribution vectors such as wind, water and animals, the spread of Sweet Vernal is now exacerbated by the transfer of mud on farm machinery and vehicles, the movements of contaminated hay, seed products and organic materials throughout Australia, and even via human clothing and shoes. The existence of large amounts of cleared land and the increasing presence of disturbance regimes in the Australian landscape has made conditions ideal for continued colonisation of Sweet Vernal into new areas (Eurobodalla Shire Council 2009). There is potential for a significant increase in the range of Sweet Vernal in Victoria and Australia. In fact, climatic modeling predicts that Sweet Vernal has a high probability of invading much of Victoria in the near future (Fig. 2) (DPI 2009). It is likely that human behavior will be the key driver of the future spread of weed species in Australia. Future weed expansions will result in an increase in magnitude of the environmental, agricultural, and social costs mentioned earlier.

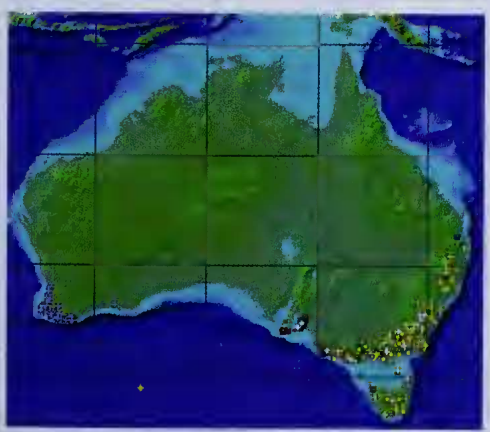

Fig. 1. Current Australian distribution of *Anthoxanthum odoratum* (AVH 2009).

Unless urgent changes are made, the following will contribute to the future spread of Sweet Vernal:

1. Climate change – Sweet Vernal is successful in a range of climates, but is particularly able to withstand hot dry weather. It is predicted that Victoria will become hotter and drier within 20 years as climate change causes rainfall patterns to shift. Research has specifically identified Sweet Vernal as a weed species with a Victorian distribution that will increase due to climate change. An in-depth discussion of climate change is outside the scope of this report; however, there is strong evidence that climate change is driven by anthropogenic factors, and urgent changes are required to address this problem (Taylor and Figgis 2007).
2. Land management practices – Sweet Vernal spreads and grows successfully in Victoria due to colonisation opportunities provided by disturbance to landscapes, including agricultural practices, land clearing, altered drainage, urban development and the degradation of natural areas. Future increase in human populations will increase these pressures, but efforts must be made to restore and protect natural habitats so that grassy weeds no longer dominate (Taylor and Figgis 2007).
3. Human attitudes – education and awareness is required so the wider community fully

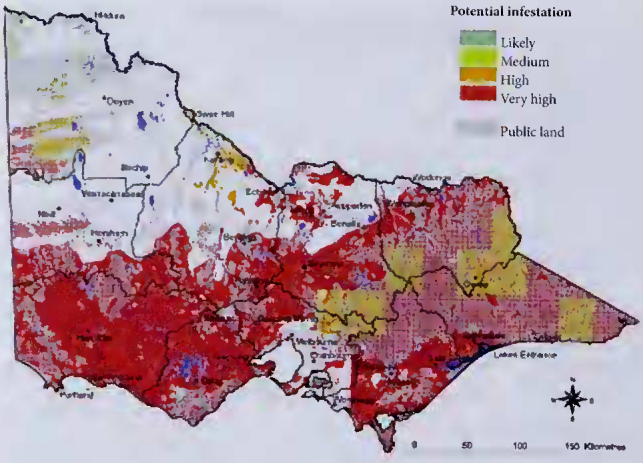

Fig. 2. Potential Victorian distribution of Sweet Vernal based on climatic modeling (DPI 2009).

understands the costs of environmental weeds, and has incentive to prevent their spread. Unfortunately, human behaviour continues to facilitate the spread of Sweet Vernal in Australia. Even in recent years, Sweet Vernal has been distributed in nurseries as 'Vanilla Grass', and is still available for sale in New South Wales and Queensland (Eurobodalla Shire Council 2009).

Conclusion

Sweet Vernal has been present in Australia for over 100 years, but has been considered a pest for only a relatively short period of time. In the last decade, distribution of Sweet Vernal has increased in southern Australia and Victoria. Unless action is taken, its ecological traits will allow it to spread rapidly, resulting in substantial costs to our environment, economy and society.

Continued research into management practices, control and prevention are required to curb Sweet Vernal invasion and reverse impacts of existing infestations. Importantly, a fundamental shift in human behavior must occur if both Sweet Vernal and many other Australian weed species are to be eradicated or controlled. This requires increased education and awareness, and the adoption of more sustainable lifestyles and practices.

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